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APRIL 1964

# Soil Conservation

SOIL CONSERVATION SERVICE • U. S. DEPARTMENT OF AGRICULTURE

## Soil Conservation
## *25 Years Ago*

"If a road ditch can be used for a terrace outlet channel, it is often less expensive, at least no more expensive, to repair and treat the road ditch for this purpose than it is to excavate and treat a parallel outlet on the land adjacent to the highway. When the road ditch is used and properly treated, the highway is benefited as well as the farm run-off disposal system. Cooperative efforts of this type eliminate duplication and provide a more stable outlet system.

"In the semiarid section of the United States, the water collected by road ditches can often be utilized to advantage by the adjacent landowner. Properly constructed intercepting terraces that tie into the road embankment will divert the surplus water to the adjacent land. This practice not only will help to prevent erosion on highway rights-of-way, but will improve the moisture conditions of the adjoining pastures or cultivated fields. This additional moisture often assures a profitable crop return where there would otherwise be a failure."

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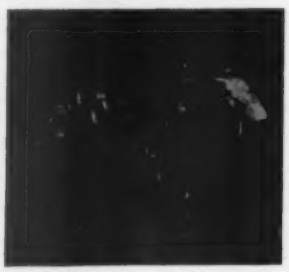

COVER PICTURE—Spring floods like this on the Red River of the North near Grand Forks, N. Dak., in April 1950 still come too often on too many of the country's creeks and rivers every year—but watershed protection and flood prevention and farm-by-farm soil and water conservation are cutting down their frequency and severity. The protruding snow-covered ridge at the right is the only "dry land," and the ripples leading off the top of the picture mark a road underneath.—Photo by Hermann Postlethwaite.

# Soil Conservation

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# *Floods Are Being Prevented Watershed by Watershed*

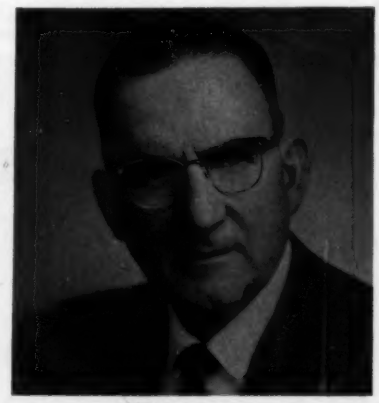
**By Gladwin Young**

DROUGHT and floods have been two of man's greatest enemies throughout recorded history. That is because their infrequency and unpredictability have tempted him to occupy flood plains when they are dry and to plow up semiarid areas in years of above average rainfall.

Too much water or too little water likewise are problems with which farmers and communities, large and small, in America have been confronted since settlement days. Today, we are seeing rapidly expanding efforts to cope with these weather-born problems through soil, water, and plant conservation systems applied on farms and ranches and in small watersheds and river basins. These increasingly effective programs, including local soil and water conservation district operations, reflect maturing public awareness of the unconscionable cost of unchallenged floods, in particular. And they bespeak, also, unprecedented support of preventive programs at every level of Government—local, State, and Federal.

"Flood control," as a function of the Federal Government, dates back to the first Congressional authorization in the Act of September 30, 1850, which authorized the control of inundation of the Mississippi River. The work was carried on by the Corps of Army Engineers, which dates its origins to 1775 but was given the "Corps" name in 1779 after creation of the Engineering Department of the Army the year before. Earlier, however, the Federal Government engaged in harbor dredging for navigation improvement, as in Mobile Harbor as early as 1826 and in Baltimore Harbor in 1836.

For the next 100 years, the emphasis was on downstream flood



**Gladwin Young.**

control on the mainstem rivers, though early in the present century Congress provided for the Federal Government to supplement and cooperate in private water resource developments. The Reclamation Act of 1902, for example, authorized water development for arid and semiarid land in the Western States. Additional authorizations were made for protection of water-producing watersheds, through the renamed Forest Service transferred in 1905 from the Department of the Interior to the Department of Agriculture; and in 1911 the Weeks law established a new national policy for Federal purchase of forest lands necessary to the protection of the flow of navigable streams.

The concept of flood prevention —then still called "flood control" —on upper watershed lands and tributary streams was born in the 1930's. Thus Public 46 of the 74th Congress in 1935, establishing the Soil Conservation Service in the Department of Agriculture, declared Congress' policy, among other things, "to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors." And the 1936 Flood Control Act authorized the Secretary of Agriculture to make preliminary examinations and surveys of watersheds and to carry out works of improvement for runoff and waterflow retardation and prevention of soil erosion.

Through the operation of both these acts, as well as under subsequent authorizing legislation, the Department of Agriculture has emphasized creek-size watershed conservation land-treatment practices and structural measures to slow down water runoff before it reaches the flood plains. This new approach, as has been borne out in practice, complements the mainstem flood control which has continued to be the responsibility of the Corps of Engineers under the 1936 and later acts. Together, they will give maximum protection from flooding and conservation of our water resources from the farthest tributary headwaters to the mouths of our major rivers.

Further to speed up attainment of this objective, the Department of Agriculture since the 1936 Act authorization also has participated in surveys for planning and devel-

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oping the water resources of selected river basins. This planning had it roots in flood control surveys carried out by the Corps of Engineers under 1928 authorization. Working through its Soil Conservation Service, the Forest Service, and the Economic Research Service, the Department cooperates principally with the Corps, the Bureau of Reclamation, the Fish and Wildlife Service, and the Department of Health, Education, and Welfare, and with States and local agencies concerned.

The watershed-flood prevention approach was extended through authority of the 1944 Flood Control Act to work in subwatersheds of 11 major river watersheds: Buffalo Creek in New York; middle Colorado River, Texas; Coosa River, Georgia and Tennessee; Little Sioux, Iowa and Minnesota; Little Tallahatchie and Yazoo, Mississippi; Los Angeles and Santa Ynez, California; Potomac, Pennsylvania, Maryland, Virginia, and West Virginia; Trinity, Texas; and the Washita in Oklahoma and Texas. Because of World War II, work was not started on them until 1946.

By the 1950's erosion control and flood prevention programs had operated long enough for landowners and entire communities to see the effectiveness of soil and water conservation practices on the runoff of surface water and the flow of streams. It was out of these combined experiences of lay people and of professional people in the Department of Agriculture that the specific proposal came to extend the soil and water conservation program in small watersheds, with Federal technical and cost-sharing assistance.

Congress in 1953 appropriated funds to start such work on 62 "pilot" watersheds, 54 of which actually were put into operation through local community-State-Federal cooperation; and in 1954 it enacted the broad Watershed Protection and Flood Prevention

**FLOOD.—High water washed away fill on north side of Canadian River in Texas, necessitating the building of 3 more bridge spans.**

**DROUGHT.—Washita River in Oklahoma stopped flowing here for first time in history in the fall of 1956.**

**REMEDY.—This Tennessee water-slowing dam is one of many which, with conservation land treatment, are helping prevent flooded and dry streams in small watersheds.**

Act (Public Law 566). The original small-watershed act was oriented specifically toward flood prevention, and included cost-sharing for nonstorage irrigation systems and for drainage. It was amended in 1956 to include cost-sharing on irrigation storage, and credit assistance for such nonagricultural water-management purposes as municipal and industrial water supply, recreation, and fish and wildlife management.

A 1958 amendment made fish and wildlife measures eligible for cost-sharing; and in 1962 the Act was further amended to include recreation developments in cost-sharing. There have been indications pointing to the likelihood of future amendments that will further enlarge the purposes of the Watershed Protection and Flood Prevention Act.

Meanwhile, the strides we have made in flood prevention and watershed protection in less than 20 years, actually, speak for themselves. Here is the score:

*11 authorized flood prevention projects*—1 completed as of December 31, 1963 (see p. 197); and structural and land treatment work finished or under way as of June 30, 1963, in 225 subwatersheds on 18½ million acres, or about 60 percent of the authorized work area.

*Pilot small-watershed projects (as of June 30, 1963)*—45 of the 54 active projects completed, and 3 each scheduled for completion in 1964, 1965, and 1966.

*Public 566 watershed projects (as of March 1, 1964)*—532 authorized for operations and cost-sharing, of which 60 had been completed; 963 authorized for Federal planning assistance; and 2,076 all together for which sponsoring local organizations had applied for Federal help.

Structural measures installed in the 3 project categories together to last June 30 had included 2,578 floodwater-retarding dams, 7,901 grade stabilization structures, 43 miles of stream channel stabilization and 1,429 miles of channel improvement, and 557,393 acres of critical area planting of grass or legumes, trees or shrubs around or on earth structures.

In addition, watershed landowners had installed—besides planting, cropping, tillage, and other practices applied through their farm or ranch conservation plans developed as soil and water conservation district cooperators—these measures: 10,144 miles of diversions, 127,481 ponds, 117,071 miles of terracing, 146,840 acres of waterways, and 13,375 structures for water control.

*River basin surveys*—The Soil Conservation Service is taking part in surveys of 29 major river basins in 37 States.

# *Buffalo Creek First of 11 Early Flood Prevention Projects Done*

**By Irving B. Stafford and Adelbert D. Ward**

THE Buffalo Creek flood prevention project in extreme western New York State made watershed protection history when it was officially terminated on December 31, 1963.

This was the first of 11 such projects authorized by the 1944 Flood Control Act in major river watersheds over the United States to complete all of the structural measures planned. Conservation practices are continuing to be applied on the upland by approximately 1,160 landowners in the watershed who are cooperators with the Erie and Wyoming County soil conservation districts and control about 40 percent of the approximately 253,000 acres outside the City of Buffalo. The application of these measures has been in progress since 1946, the year that flood control work, which had been suspended during World War II, was resumed; and stream channel improvement operations and structural measures were started in the fall of 1949. The operations in Buffalo Creek, as in the 10 other watersheds, have been carried on with Soil Conservation Service technical and financing help, in cooperation with soil conservation districts, other local and State organizations, and the U.S. Forest Service.

Actual monetary benefits obtained from alleviating sediment damage to industrial water, infertile deposition, swamping, and transportation are not yet available; but information recently released by the Agricultural Research Service at East Aurora indicates that a 3 percent reduction in sediment discharge into Buffalo harbor has resulted in a reduction in dredging of 24 percent, at an annual savings of $56,000, including maintenance costs.

The Buffalo Creek watershed, which lies in the central part of

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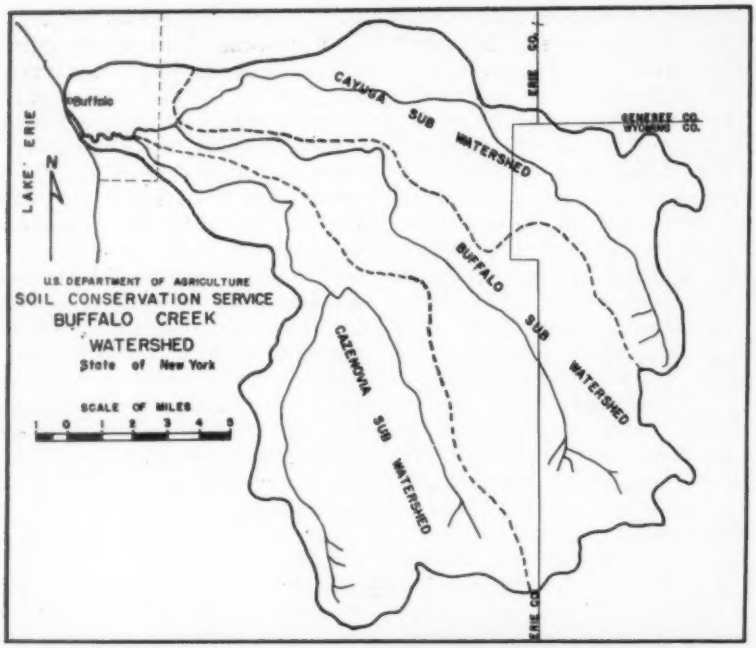

**Streambank protection work in progress on Cazenovia Creek.**

**Legion Dam grade stabilization structure nearly completed.**

Erie County and in the northwestern corner of Wyoming County, is drained by three subwatersheds: Buffalo Creek containing 172 square miles, Cayuga Creek containing 125 square miles, and Cazenovia Creek containing 140 square miles.

Buffalo Creek was selected as a flood prevention project on the basis of results of a detailed survey of the flood- and silt-source areas of the watershed made by the U. S. Department of Agriculture in 1938 under the authorization of the 1936 Flood Control Act; and a program was recommended including: Treatment of farmland to reduce runoff and erosion; treatment of submarginal land recommended for public purchase; and stabilization of streambanks to prevent their erosion.

A revised report in 1955 indicated average annual damages in the watershed on a long-term price base totaling $346,017, made up of: $241,607 from sediment; $67,263 from erosion, and $37,147 from inundation. Sediment thus was shown to account for about 70 percent of the damage—sedimentation of Buffalo harbor, damage to highways and railroads, cost of removing sediment from industrial water, and land damage through infertile deposition and swamping.

Detailed surveys of the watershed showed sheet erosion and streambank erosion were the two major sources of sediment in Buffalo harbor. It was estimated that 25 percent of all the sheet erosion material deposited in the three major subwatershed streams reached the harbor. After field surveys were analyzed, and allowances made for areas where streambank protective measures would not be justified, it was estimated the overall reduction in sediment damage from streambank erosion would be 53 percent.

The study showed that 47 percent of the damaging sediment in Buffalo harbor originated from sheet erosion and 53 percent from streambank erosion. Sediment damages were based on figures obtained from the U.S. Army Corps of Engineers, charged with the responsibility of maintenance dredging of the harbor, and from highway officials, railroad companies, and industries in Buffalo using raw water from the harbor, and on an analysis of data on sediment damage to bottom land. They included damages to the harbor of $129,485; to industrial water, $2,500; from infertile deposition, $11,076; from swamping, $5,226; and to transportation $93,320—for a total of $241,607.

The average annual benefit of the flood prevention program, based on that summary of sediment damage in the watershed, was calculated at $107,351. This total included reductions in damage and annual benefits of: Harbor—45 percent and $58,268; industrial water—46 percent, $1,150; infertile deposition—58 percent, $6,424; swamping — 80 percent, $4,181; and transportation — 40 percent

and $37,328.

Reduction of sediment damage in the watershed was only one aim of the project, and reduction of dredging costs was only one part of sediment damage. Annual benefits to the harbor alone are more than half of the original estimated benefits for all types of sediment damage in the watershed.

ARS figures show that from 1944-53 an average of 185,141 cubic yards was dredged annually from Buffalo harbor and 76,252 cubic yards from its entrance. By 1957, approximately 75 percent of the streambank stabilization work had been completed in the watershed. In the 6-year period since then, slightly more than 140,000 cubic yards has been dredged annually from the harbor—a reduction of 24 percent.

The major conservation measures applied on the streambanks by the SCS since 1949 include: Streambank protection, stream channel improvement, clearing and snagging, stream channel stabilization, dikes and levees, grade stabilization structures and structures for water control, and critical area planting.

Land treatment practices include such structural devices as diversions, drainage ditches and tile, farm ponds, grassed waterways, and spoilbank spreading; and such planting and other vegetative practices as tree planting, pasture and hayland planting and wildlife area improvement, and stripcropping.

Easements and rights-of-way for the installation of structural measures along the streambanks were provided by the Joint Board of the Erie and Wyoming County soil conservation districts, which also have the responsibility of maintaining the streambank protective measures. Annual maintenance costs are shared cooperatively by Erie ($3,500) and Wyoming ($1,500) counties, and by the New York State Conservation Department with matching funds up to $2,500.

# Research Seeks Best Techniques For Stabilizing Stream Channels

By Robert P. Apmann

TECHNIQUES for more effective and economical stabilization of streambanks in watershed protection and flood prevention projects over the whole country are being studied by the Soil and Water Conservation Division of the Agricultural Research Service on Buffalo Creek in New York and the Pequest River in New Jersey.

These two streams were selected for this research because their own channel improvement projects provide ready-made opportunity to study stream behavior and stability. Buffalo Creek, where the research was begun in 1952, is one of the 11 major watersheds for which flood prevention operations were authorized by the Flood Control Act of 1944. The planned streambank stabilization, complemented with conservation treatment of watershed lands, was completed in 1963.

The research was extended to the Pequest River in 1958. It was one of the more than half a hundred pilot small-watershed projects that went into operation the year before enactment of the 1954 Watershed Protection and Flood Prevention Act (Public Law 566), authorizing Federal technical and financial help for State-approved local projects. Federal technical and financing assistance for all flood-prevention projects is provided through the Soil Conserva-

Buffalo Creek bank protected by experimental revetment blocks.

The author is hydraulic engineer, Northeast Branch, Soil and Water Conservation Research Division, Agricultural Research Service, East Aurora, N.Y.

**Test reach on Pequest River in New Jersey.**

tion Service in cooperation with other U. S. Department of Agriculture agencies.

Specifically, the research studies are directed toward developing good engineering information for use in designing and constructing stream channel stabilization works. Such information can provide more accurate cost data on stabilized channels. Therefore, the research results are highly important to the designer, for the costs of adequate bank stabilization works are dependent on his judgment.

For a rational design of stabilization works, the designer must consider both the potential ability of the stream to erode its banks and the ability of the banks to resist the attack of the stream. An analysis must be carried out for all parts of the floodway in which stabilization is to be assured.

The erosive potential of a stream depends upon the forces which it exerts on the banks and the bed. Since the most important forces are the pressure and the drag of the water against its boundary (boundary shear stress), it is necessary to determine the intensities of these forces at all points of the stream channel. The resistive ability of the bank protection works depends, among other things, upon the size of the revetment material, where on the streambank the material is placed, and upon the method of construction.

The general procedure for the studies is to make intensive field measurements of selected floods to gain information on such important qualities of stream behavior as mean water speeds, mean boundary shear stresses, mean retardance coefficients, and the dissipation of energy by the stream. This information is then matched to the properties of the areas where incipient or minor bank damage has occurred during the flood flows. This matching gives the resistive abilities of the banks in terms of the important qualities of flow behavior.

Laboratory studies are used to provide additional information.

**No. 74**

**This is the seventy-fourth of a series of articles to appear from time to time in explanation of the various phases of research being conducted by the Department of Agriculture on problems of soil and water conservation.**

On Buffalo Creek, the fieldwork is done on a 5-mile-long reach that includes a variety of such conditions as bed material, bed slopes, and stream channel bends. Some banks are reveted but others are not. Thus, it is possible to study the resistive abilities of both natural and protected banks.

Measurements in the reach depend on the passage of floodwaters of about bankfull stage. Streamgaging procedures are used to determine the peak discharge of the flow, and high-water marks are placed and surveyed after the flow passes. A complete topographic map of the stream channel was made from the 500 cross sections which were surveyed in the reach. These cross sections are rerun whenever significant changes occur in the channel shape.

Certain mechanical properties of the bank material are measured, such as riprap stone size and density, and cohesiveness of the soil. These different measurements are generalized somewhat by the use of dimensionless parameters and then applied to other similar stream situations.

Three study reaches were selected on the Pequest River, each being 1,000 feet long and having a different degree of bank stability. In contrast to Buffalo Creek, the bed slopes are less, and the bank material is smaller. Soil samples taken from the three reaches have been analyzed in a special laboratory flume at the National Sedimentation Laboratory at Oxford, Miss., for their ability to resist the erosive force of flowing water.

The resistive abilities of the banks cannot be measured entirely by the qualities of stream behavior, because bank failures may be accelerated by weaknesses arising from other causes. Some of these are: Ground water flow out of the banks, inadequate protection to the revetment toe, flow over the revetment top, attack of ice and debris, and inadequate or improper use of

vegetation. Analysis of these weaknesses and the development of procedures to counteract them are important parts of the research.

The primary procedure here is the observation of major damage to the banks. Any major damage from floods is carefully documented, and the causes of the damage are sought and related to the particular procedures that were used to build the banks. Recommendations for improved designs and procedures result from such observation. To aid in this study, a complete, illustrated history is kept of each reveted bank.

Suspended sediment samples taken for 10 years at three locations in the Buffalo Creek watershed as a collateral part of the research have shown the usefulness of revetment works for reducing sediment yield, by a decrease of about 40 percent. Almost all of this reduction resulted from the construction of revetment work by the SCS. Only about 40 percent of the total stream was reveted; but since the revetment was mostly placed in channel bends, this work effectively controls most of the streambank erosion.

# Flood-Proofing Pays Off for Indiana Farmers and Their Towns

By Kent Alverson

FLOOD-PROOFING of the 8-mile-long and 4-mile-wide Elk Creek watershed in southeastern Indiana's Washington County is paying off for the area's half a hundred farmers and for the nearby towns where they market their truck crops and livestock.

This was the first project in the State to be completed with Federal help to local people through the Watershed Protection and Flood Prevention Act. It is one of a dozen Public Law 566 projects approved for operations in Indiana by January 1 this year, out of 24 authorized for planning among 69 project applications. Fields in Elk Creek valley were being flooded 3 to 7 times a year. One year there were 7 floods by August 1.

In the words of farmer Harry Jackson who, with his neighbors, had fought a lifetime battle with ruinous floods and marshaled all the resources available to put an end to them: "The operation was successful. We're thankful for this and glad it's all over."

Close to 35 acres of the Jackson farm had been devoted to defense purposes only—kept in trees and bayous to prevent scouring. As recently as 1960, a fast-developing flood took most of his crops and almost got his cows, too. Afterward, he had to "work out" to keep the family going. "I can farm the bottoms harder now and keep erosive hill land in pasture the way it should be," he said, "and I'm going to try some new truck crops now that farming is less risky."

Jackson's feelings are typical of those now prevailing throughout the Elk Creek watershed area.

The Elk Creek project had its beginning in 1952, at the instance of affected valley farmers like Junior Spaulding and Paul Garriott, Jr. An elected 11-men steering committee resulted from a farmers' meeting held in March 1933 in the Little York schoolhouse, at which Don Hinckle of the Salem Soil Conservation Service office explained the watershed approach to their problems.

The committee petitioned the Washington County Soil Conservation District for the SCS to check the feasibility of a watershed project; and immediately after the national Watershed Protection and Flood Prevention Act

SCS Administrator D. A. Williams speaking at 1963 dedication of watershed.

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was approved in 1954, Elk Creek landowners applied for the Federal technical and financing help it offered to responsible local community organizations that could qualify. It was one of Indiana's first two such applications.

The people pool efforts to get jobs done. For the local share of watershed project costs, for example, they raised all the money by voluntary contributions. All land, easements, and rights-of-way were donated.

The Elk Creek Conservancy District was formed to raise the money to carry out the project, with Joseph Scifres, chairman; Paul Garriott, Jr., vice-chairman; and Hager Garriott, assistant soil and water conservation district supervisor, as secretary-treasurer. A selective cutting program followed by Hager and Orville Garriott on their approximately 1,200 acres of timbered upland helps to keep the watershed hills free from erosion.

Elk Creek rises in steep lands, locally known as "The Knobs," and is joined by five tributaries before it reaches a constructed canal that leads to the Muscatatuck River. Waters of the creek and its tributaries gain considerable velocity and have cut a complex drainage pattern into the relatively flat lowlands to the northeast. The flood plain is 1¼ miles wide at the confluence of Elk Creek and the canal.

Conservation measures, planned with SCS help to match the problems, include contour farming, tree planting, terrace construction, pasture establishment and improvement, pond construction, improved surface and tile drainage, and wildlife habitat improvement, along with seven major floodwater-retarding structures and 10 miles of downstream channel improvement. Landowners have applied more than 90 percent of the on-farm practices, and the last major structure was completed in 1963.

Water control, both in storage and removal, is the key to success in the Elk Creek watershed. The earth dams, built at strategic locations, provide both temporary and permanent water storage. Several landowners paid up to $5,000 apiece as their share of the cost for building additional irrigation water storage into each of three structures. Total cost to the Federal Government for flood prevention was $620,000. The local cost was about $240,000.

Because the Indiana Department of Conservation's Division of Fish and Game became interested in developing one of the structure sites for fish and wildlife, two of the planned structures were combined into one larger one, and the State bought 320 acres for development of a lake and wildlife habitat. The lake has 47 acres of water surface. It can be drained when necessary to restore the fish population balance. Parking and boat ramp facilities are being constructed, and the area will be open to public fishing and hunting.

**Choked streams used to flood adjacent fields.**

All together, seven new bodies of water have been created, ranging in size down to 3 acres. The other six structures are owned by farmers.

Most striking developments so far from water control are the changes in the land-use pattern and the diversion of corn and soybean acreages to vegetable crops. Livestock numbers are about the same, but pasturing now is mostly in the uplands on improved pasture. Shifting to truck crops on the best land is being encouraged by a large, independent cannery with plants at nearby Scottsburg and Austin. There is about 3,500 acres in the watershed that eventually could go to truck crops.

Hager Garriott irrigates two crops of green beans a year from a 12-acre pool behind the dam on his land, getting 4 to 6 tons an acre. His sweet corn averages 4

**This flood detention reservoir also is used for irrigation and recreation.**

tons an acre and cabbage about 20 tons. He and his brother, Orville, pay out $1,000 a year, mainly to high school boys, to cut and load cabbage.

The trend to truck crops is growing, and the canning factory at Austin is increasing its capacity and taking more kinds of vegetables. Last year, it contracted 100 acres of beets and 70 acres of sweet potatoes.

Hager Garriott pointed out that while there is more gamble in truck cropping because of weather hazards, insects, labor costs, and so on, elimination of flooding and drought hazards by watershed structures has made it profitable. He now grows only 25 acres of field corn, and this to feed to 30 head of steers.

Paul Garriott will tell you how successful the Elk Creek project has been in controlling flooding. As recently as January 1960, when the watershed installations were only 20 percent completed, floodwaters rose 2 inches on his front porch steps. With all the structures in, the floodway channel ran only two-thirds full after a 3.6-inch rain in March 1963 on frozen ground; and Garriott said that "without the project we would have had floods in March, May, and July, I am sure."

There are now close to 10 miles of blacktopped roads in his township. Because of past experience with floodwaters, the road commissioner had refused to do more blacktopping until floods could be controlled. Four county roads were closed four or five times a year, cutting off school buses and milk routes. With road ditches now able to handle the water runoff, one bridge has been taken out and two more are expected to be removed. Road damages now are slight, but in an adjoining untreated watershed a February 1962 flood resulted in a $3,000 expense to replace crushed stone on the roads.

Paul Garriott, who has shifted his corn acreage to truck crops, said: "I wouldn't be growing factory beans if it hadn't been for the watershed project."

He has spent considerable money bulldozing the old bayous and tiling them out. He also plans to do some land leveling.

The work plan for the Elk Creek project estimates annual visible benefits at $1.89 for every dollar spent. But there are many rural area development fringe benefits, too: Dependable crops and higher profits mean the entire economy gets a boost. Every pool of water at structure sites provides an opportunity for fishing and other outdoor recreation. And, with better wildlife habitat, the State can increase deer, game birds, and other desirable wildlife.

# Yazoo-Little Tallahatchie Is a Paying Flood Prevention Project

By W. L. Heard

AN economic revolution already is spreading its benefits throughout the north-central fifth of Mississippi that lies in the Yazoo-Little Tallahatchie flood prevention project although the $70 million job is only about halfway to its 1970 completion target.

One of the biggest conservation jobs yet tackled in the United States, the Yazoo-Little Tallahatchie is one of 11 such projects in major river watersheds on which cooperative Federal-State-local work got under way after World War II, as authorized by Congress in the 1944 Flood Control Act.

More than 50 subwatershed projects, sponsored by local commissioners of water management and by soil conservation districts, already are in operation in the 4-million-acre project.

Gullies like this—pictured before planting to kudzu for flood control—once were common in project area.

Subwatershed accomplishments include 159 floodwater-retarding structures—about one-fifth of those needed—9,000 desilting basins, and 1,500 miles of diversion ditches constructed and 800 miles of stream channel improved. Great strides also have been made in applying land-treatment measures that eventually will include more than half a million acres each of pastures and conservation crop rotations and almost a million acres of trees. Pastures have been established on more than 100,000 acres, and pines

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**Floodwater-retarding dam protects valley land in foreground.**

**Water behind flood prevention project dams provides good fishing.**

planted on still another 410,000 acres.

The Soil Conservation Service and the Forest Service provide technical assistance. Other agencies which have played a part in the flood prevention project's development include the U. S. Corps of Engineers, which established the first big dams at Enid, Sardis, Arkabutla, and Grenada; the Farmers Home Administration, and the Agricultural Stabilization and Conservation Service; the Mississippi Extension Service, and the State Board of Water Commissioners.

Cut across the north Mississippi hills in the Yazoo-Little Tallahatchie project counties that begin at the Tennessee line and extend well below Oxford, and you will see men harvesting timber out of young forests — timber for growing industries that employ hundreds of men and women who would have had to leave the region for lack of jobs only a few years ago. You will see fine livestock that has replaced the scrub herds of yesteryear grazing in improved pastures.

You may travel between hundreds of miles of roadbanks that formerly poured a crushing load of silt and sand into streams in the region, but which now are protected and beautified with kudzu and flowering shrubs planted to check erosion. Veer off onto the side roads that follow the ridges and you can see people from many sections fishing in reservoirs built for flood prevention. In 1962, 34,695 recreational visits were reported at 91 reservoirs.

Elsewhere in the many subwatershed projects which make up the Yazoo-Little Tallahatchie program, you can see crops growing on protected bottom land, vacation homes overlooking the lakes, and cattle auction barns packed with buyers.

By the time of the flood prevention project's beginning, close-cropping had so exhausted the once rich land that thousands of farmers were struggling on less than $300 in family income a year. Just one many-fingered gully in Panola County, called the "Jime Jones Gully," had ruined 21½ acres. The SCS estimated that all together 100 million tons of sand and silt gushed out of these northern Mississippi hills each year. Valley farmers, meanwhile, were losing one out of every five crops.

The 20,000-acre Askalmore Creek watershed, which rises above the Delta flood plain in Tallahatchie County, provides one of many examples of project-wide progress: The estimated annual flood damage was $46,000, and a single storm in 1957 did $95,300 worth of damage to crops, land, and improvements. But in 1963 the watershed project treatment measures completely controlled a comparable 4-inch rain.

# *Five Kansas Watershed Projects Joined in Flood—Other Benefits*

By Leslie E. Johnson

FLOOD prevention is the major but not the only benefit rewarding the people in and around Chatauqua County for their persistent community efforts in making reality of their 10-year-old idea for watershed development in the Kansas portion of the Caney Basin along the Oklahoma line. Other accomplishments in the making include more and better water usage, outdoor fun, and, in short, better living all around.

The Kansas-Oklahoma Caney Council of Soil Conservation Districts was formed more than a decade ago to represent the interests of the people living within the upper part of the Caney River Basin. Clyde Clubine, Frank Ferguson, J. O. Henderson, and Walter Sears recall that they and their fellow original Council members were convinced watershed development was needed, because floods came too often, and sometimes there was too little water in dry spells. When the pilot small-watershed program came along in 1953, the Council was ready.

The group was able to obtain two projects, in the Aiken watershed on the upper end of Bee Creek in Kansas (see SOIL CONSERVATION, March 1964, p. 189) and on Double Creek in Oklahoma. The pilot watershed floodwater dams were ready in 1957 when drought-ending rains came in overgenerous amounts. They showed how upstream floods could be tamed and what a blessing additional water is.

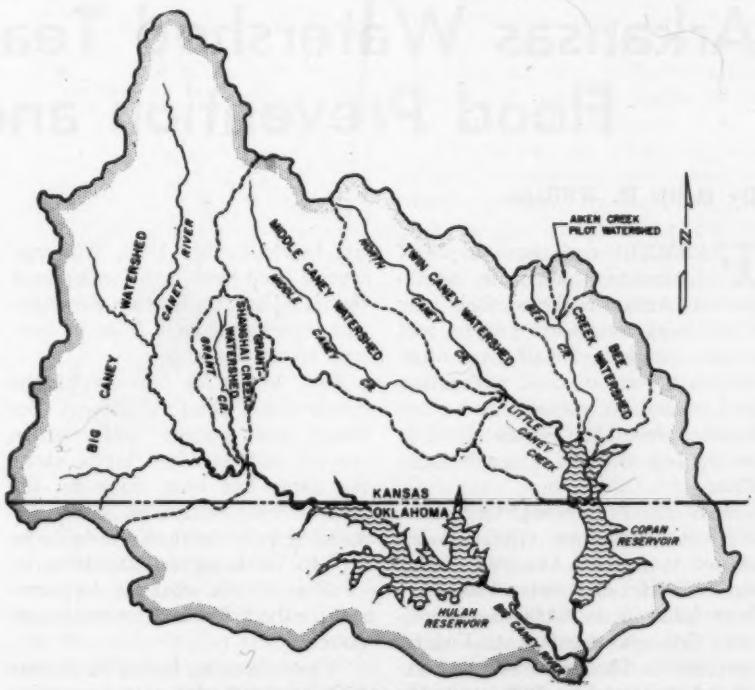
Under the Kansas Watershed District Act of 1953, four watershed districts totaling 542,000 acres in the Kansas portion had been organized: The Grant-Shanghai, Bee Creek, Big Caney, and Twin Caney.

An interwatershed committee was formed, made up of representatives of each district board of directors, with Thad Kinnaman as executive secretary. The committee first employed an engineering firm to make aerial photographs of the Kansas portion of the basin for use in watershed planning. The cost was divided among the districts in relation to area, after deducting some contributions from towns in the area.

The committee set out to get priority for planning help under Public Law 566, the Watershed Protection and Flood Prevention Act, which had been authorized by Congress in 1954. In 1960, it applied for authorization to plan watershed projects in all four watershed districts, using $90,000 of newly appropriated State funds for the engineering phases of the work.

By 1961, five projects had been approved for Federal planning assistance—Bee Creek, Twin Caney, Grant-Shanghai, Big Caney, and the Middle Caney. All had been authorized by March 1, 1964, to receive Federal assistance for construction.

All together, the 5 Caney watershed projects, when completed, will include 78 floodwater-retarding reservoirs, 2 multiple-purpose reservoirs, and 45 miles of channel improvement. Three of the Bee Creek dams already are about three-fourths completed.




The Caney Basin's 5 watershed projects.

The author is assistant State conservationist, Soil Conservation Service, Salina, Kans.

**Boy Scouts learning to swim in the Aiken Watershed reservoir.**

Total project costs, including land treatment for watershed protection now in various stages of completion in the five watershed project areas, come to $13,324,000, with $10,662,000 Federal cost and $2,662,000 from other sources. Sedan, county seat of Chatauqua County, is financing a 660-acre-foot multiple-purpose reservoir in the Middle Caney watershed project, to provide water for its growing population and water supplies in drought years.

In the Twin Caney, the Quivira Council of Boy Scouts, which includes Wichita, is developing a 400-acre lake as part of the development of its 2,800-acre Scout Ranch as a wilderness camping site. The Council agreed to provide land, engineering, and construction funds with an aggregate value of $237,000 to cover its share of the lake's cost. Others, meanwhile, are exploring the recreational potential in different parts of the Caney watershed.

Thus are the water resources of the Kansas part of the Caney Basin being developed for multiple uses in addition to taming the floods that used to occur so frequently. A balanced system of large, intermediate, and small dams is being installed to establish a proper relationship between upstream and downstream interests in the basin. The benefits are widely dispersed, and everyone in the area stands to share them in one way or another.

# Arkansas Watershed Team Speeds Flood Prevention and Recreation

**By Hollis R. Williams**

FARMERS and townspeople of Lawrence County in northeastern Arkansas figure their new Flat Creek watershed project will return upward of half a million dollars a year in flood prevention and related recreational and other benefits from the water developments and controls it has brought them.

Five floodwater-retarding dams and one structure specially designed to provide abundant water for wildlife and recreation have been built in the 24,000-acre project through local-State-Federal teamwork. The first one was completed in October 1961 and the last in September 1963. The reservoirs and yet-to-be completed 4½-mile-long floodwater diversion will intercept runoff from 99 percent of the uplands.

Also, about 75 percent of the conservation land treatment for water management and erosion control on watershed lands above the dams has been done by the landowners. Structural work remaining to be finished also includes 8 of the little better than 10 miles of Flat Creek channel improvement called for in the watershed plan.

When planning began in the late 1950's, aimed at better protection of the 6,200 acres of flood plain, project benefits were estimated at about $50,000. Although they were twice that amount when operations were authorized in 1959—because fish and wildlife benefits had been added under an amendment to the 1954 Watershed Protection and Flood Prevention Act—the State and local people also wanted a recreation park beside the 645-acre Lake Charles. That is the dual-purpose reservoir for flood prevention and fish and wildlife.

The author is deputy administrator for watersheds, Soil Conservation Service, Washington, D.C.

Money for park facilities was not in sight, but the Arkansas Game and Fish Commission already had bought 80 acres of land for the purpose; and when Congress in the 1962 Food and Agriculture Act authorized cost-sharing for this kind of recreational development in small-watershed projects, the Commission and the cosponsoring Lawrence County Soil Conservation District arranged to amend their plan to include the park.

Facilities now being established will accommodate up to 10,000 people a week in season, or an estimated 200,000 visitor-days a year; and the estimated eventual watershed benefits accordingly have been boosted to a whopping $400,000 a year, or eight times as much as when the project was conceived.

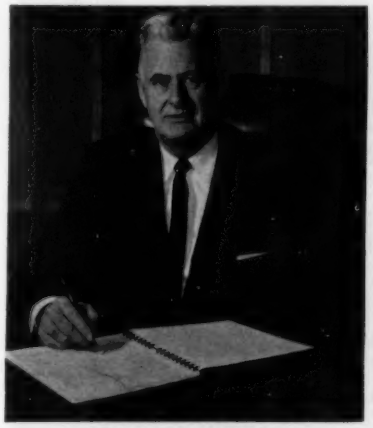
The measure of the Flat Creek watershed project is more a matter of the vision of its people who were willing to invest in full development of the area's natural resources than it is of size, or even of these impressive benefits. Take, for example, the late James F. Sloan of Walnut Ridge:

He helped pioneer the Tri-River Soil Conservation District organized by landowners in 1938 under the Arkansas State districts enabling act, the first such law in the Nation. Part of the present Lawrence County Soil and Water Conservation District was in that district, and part in the Moorefield district formed in 1939.

"Some day," Sloan declared as time after time he saw muddy water swirl out of Flat Creek and destroy crops on the ferfile bottom lands, "we will treat the hill land that sheds its water so fast. We will build dams to hold back that floodwater, and we'll use it for many purposes."

He led the district program that started the land treatment immediately, but he had to wait until the midfifties before Congress authorized the watershed program that has made his prophecy come completely true. R. Sloan Rainwater, farmer and businessman in Walnut Ridge, succeeded to this local leadership when the watershed program came along.

When wildlife interests later were joined with the basic watershed program, fellow townsman Charles C. Snapp was chairman



Hollis R. Williams.

of the State Game and Fish Commission. His group sought water to flood 2,700 acres of lowland hardwoods on the adjoining Shirey Bay-Rainey Brake Wildlife Refuge, for the many ducks that visit the area during the winter. Under his leadership the Commission became one of the first State game and fish agencies to cosponsor a watershed project. Snapp is now a member of the board of supervisors of the Lawrence County Soil and Water Conservation District. Lake Charles bears his name.

Various other community, county, and State leaders have been active on or in support of the watershed project team, including everybody from the Governor and members of Congress and the State Legislature from this part of Arkansas to the Flat Creek Watershed Improvement District. State agencies have made major contributions from the project's outset.

The Game and Fish Commission spent more than $100,000 for fish and wildlife developments in the watershed, in addition to more than $300,000 it invested in the Shirey Bay-Rainey Brake refuge.

State Highway Commission contributions similarly will exceed $100,000. It re-routed 1.1 miles of State Highway 25 so the Lake Charles dam could be moved to the edge of the flood plain, where it could store water for fish and wildlife. The Commission also is building 2.2 miles of hard-surfaced roads and parking areas in the recreational development.

The Arkansas Publicity and Parks Commission, under new authority granted by the State Legislature, is contributing $60,000 for the minimum basic recreational facilities, and will operate and maintain the park at an estimated cost of $60,000 annually. It also will build a cottage for a caretaker.

Among Federal agencies, the Soil Conservation Service gave primary assistance in planning, construction, and cost-sharing. The Farmers Home Administration made a $30,000 loan to the Flat Creek Watershed Improvement District in 1963. The Forest Service planned the recreational facilities and helped with land treatment. The Agricultural Stabilization and Conservation Service, Ex-

Lake Charles while still filling, with work under way on park at right.

Lake Charles water supplies Hill Slough in wildlife area.

Visiting first dam completed (l. to r.): SWCD Chairman R. S. Rainwater, Rep. Wilbur D. Mills, Walnut Ridge Times-Dispatch Editor James Bland, Jr., Attorney Leonard Lingo, SCS State Conservationist William B. Davey, SWCD Supervisors Earl Sloan and J. F. Sloan III; and Dr. Edwin Dunn and W. H. Haley, Flat Creek Watershed Improvement District commissioners.

tension Service, Fish and Wildlife Service, and others also helped.

The local people actually made the greatest contribution—in leadership and services that cannot be measured in dollars, in addition to their actual financial investment on the project. Thus landowners put $150,000 into land treatment and gave $100,000 in easements and rights-of-way. Grading and sanding the swimming beach by the Lawrence County government is valued at $15,000. The sand was contributed by a local businessman. Outside wiring in the park, valued at more than $4,000, was contributed by the Craighead County Electrical Cooperative.

The fishing and hunting and other recreational facilities of the Flat Creek watershed project will be available to the people of the surrounding tri-State area of Arkansas, Tennessee, and Missouri. The project will provide new job opportunities in a county that has had underemployment; and it will increase rural and urban income, and help to stabilize the economy of an area much larger than the 24,000 actual project acres.

It is practical Rural Areas Development!

## 11th Watershed Congress Looks Ahead 10 Years

Watershed development during the next decade was the theme of the 11th National Watershed Congress at Little Rock, Ark., April 26-29, with the annual banquet address by Secretary of Agriculture Orville L. Freeman, and the opening keynote address by Deputy Administrator Hollis Williams of the Soil Conservation Service on the first 10 years' progress in watershed development.

Committee reports were the principal bases of discussion, on water quality; recreation, fish, and wildlife in watershed development; river basin planning; water rights, and the potentials of watersheds.

# Little Sioux Flood Prevention

## Helps Many Watershed Landowners

By Harvey R. Lindberg

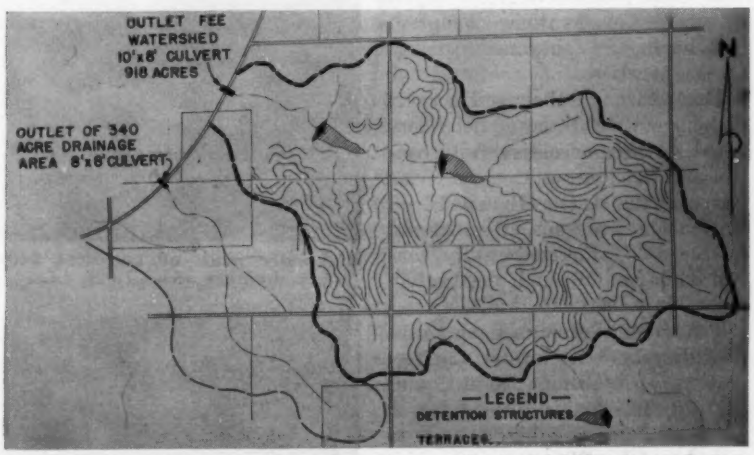
SEVENTY-FIVE landowners in the Cherokee Soil Conservation District in Iowa are enjoying profit and pleasure from six small watersheds they have protected and improved through the Little Sioux flood prevention program.

Working together, these neighboring farmers invested more than $25,000 to establish soil and water conservation measures on their land. They put another $25,000 into a fund, deposited with the district, that guarantees maintenance of the erosion control and detention dams built with flood prevention program assistance. Serious gully problems and rilling in cropland, flood damages, the need for water, and interest in conservation were the farmers' major problems.

Work in the first of these six watersheds was completed in 1950, among the earliest in the Little Sioux program. The latest was finished in 1961. The Cherokee County watersheds are midway of the 2,880,000-acre Little Sioux Flood Prevention Project, extending 135 miles out of southwestern Minnesota to the confluence of the Little Sioux River with the Missouri River approximately halfway between Sioux City, Iowa, and Omaha, Nebr.

Eight soil conservation districts are principally concerned in carrying out the Little Sioux project—one of 11 authorized in as many major river watersheds of the country by the 1944 Flood Control Act—and 4 other districts have some interest in the program. Forty-nine subwatershed projects had been completed by June 30, 1963.

The six subwatersheds in the Cherokee district are representative. They vary in size from 918




During Aug. 8, 1961 storm 340 untreated acres (l.) had 1,020 c.f.s. peak flow, while adjacent 918 treated acres in Fee watershed had only 410 c.f.s.

Detention dam on Walter and Robert Mortenson land, with diversions used to stabilize side gullies.

The author is work unit conservationist, Soil Conservation Service, Cherokee, Iowa.

to 2,220 acres, for a total of 8,000 acres. The smallest includes 8 farms and the largest 20.

These 75 farmers are contouring more than 4,000 acres of cropland. They built 67 miles of terraces and 28 acres of waterways. They seeded 11,000 rods of headlands and planted 20 acres of wildlife areas. They shifted 112 acres of hilly ground to permanent pasture and installed 2 dams and 5,000 feet of diversions. Those measures were all applied by the landowners with technical help of the Soil Conservation Service. Agricultural Conservation Program cost-sharing was obtained on many of the practices.

Then, through their soil conservation district, these neighbors asked for help on major gully control and flood prevention problems through the Little Sioux Flood Prevention program administered by the SCS. Fourteen gully control dams and 16 small floodwater-detention dams were built.

The detention dams also are providing both stockwater and recreation — hunting, fishing, and boating. The ponds formed by 13 of these dams are big enough to support fish. They vary in size from 1 to 8 acres, and have a total of 53 acres of water surface. Eleven have been stocked variously with bass, bluegills, catfish, and bullheads. Seven of the dams have water piped to a stock tank below the dam.

The supreme test for one of these small watersheds came on August 8, 1961, when 10 inches of rain fell in 6 hours in an area southwest of Quimby. Although the runoff was greater than the detention dams were designed for, no significant damage occurred to them, little damage was done to the cropland terraces, and terraces in meadow fields handled the storm with little or no overflow.

John Hodgodon, in the lower part of the watershed, said that a few years ago a 7-inch rain produced a flow that put 1 foot of water at his front porch, approximately 150 feet from the stream channel, but that the more recent 10-inch rain produced no overflow in the channel, which flowed at only about 50 percent of its capacity during the peak flow.

**High-water mark of untreated 340-acre drainage area—1,020 c.f.s.**

**High-water mark in treated Fee watershed—only 410 c.f.s.**

"Water runoff has been reduced to the point that fencing the creek bottom is no longer a problem," Harold Clark reported. "Terraces have checked the small gullies and made waterways possible. The top of the flood-detention dam gives me an all-weather lane to my fields. My son-in-law caught a 5-pound bass in the lake formed by this dam. My pond is used for both fishing and boating and provides stockwater for the pasture."

"There has been a steady increase in yields of all crops since we started our conservation program," Walter and Robert Mortenson commented. "Also, the dam in our west gully checked a serious threat to one of our feed yards. All the gullies are now protected waterways. Our pond serves as a standby source of stockwater. In the dry year of 1956, we pumped water from the pond to irrigate an adjacent field and supplied water for a neighbor's pasture."

Estimating that considerably more than 100 people fish and hunt in this small watershed every year, Keith Robeson observed that "duck and goose hunting has been tops in our watershed."

James Fee and his son-in-law, Kenneth Hoeppner, had this to say:

"Our well is now full of water, where before the watershed treatment a gully was draining it. Also, the terraces made it possible for us to use a more intensive rotation, and we used the pond to irrigate one field in 1956. This has increased our income. I have seen as many as 12 people fishing the pond on many days, and there are ducks and geese in the fall."

Doyle and Dean Simonsen added this observation.

"Watershed improvements have resulted in a big reduction in fence-maintenance costs. Our annual watershed maintenance payments are no larger than the annual saving in fence costs. We don't particularly like terraces, but they have cured the small gullies in our hill land; and ditches below are healing, because runoff water is reduced. Also, we now cross the flood detention dam to reach distant crop fields, and every once in a while somebody reports catching a big bass in the pond."

# Washington Farmers Solving Problem of Too Much Water

By Everett Loreen
and Herb Boddy

LONG-SUFFERING bottomland farmers near Snohomish in northwest Washington this year are tasting what they expect to be permanent relief from costly floods they have seen come and go just about every winter before.

Two flood projects, costing nearly $8 million, already have demonstrated their potential effectiveness for ending winter inundations that made an "inland sea" of their fertile valley. These two community-initiated and -run watershed projects—Marshland and French Creek—on opposite banks of the meandering, trouble-bent Snohomish River, are designed to protect 184 farmers and some 12,000 acres of truck and dairy lands.

This spring, for the first time, they are in position to plant new and better-paying vegetable crops and pastures. And with wet lands high and dry, yields of old crops can be stepped up and low-producing lands put in top working order. Changing from dairying to higher-valued row and drill crops could increase farm incomes in the valley by $500,000 a year. The yearly flood damage saving resulting from the projects is estimated at $265,000. All together, farm and urban people in the valley and surrounding areas thus will share project benefits figured at more than three-quarters of a million dollars a year.

Floods have caused destruction, and even death, in the Snohomish Valley since pioneers first settled there. Swelling waters from the Snohomish and Pilchuck rivers, along with neighboring streams, flood the French Creek and Marshland farming areas as often as 10 times a year. Tidal action from close-by Puget Sound on the west below Everett adds to the flows and increases the length of time floodwaters stay on the land.

To reduce floods, farmers in the past had organized drainage, diking, and improvement districts and installed low dikes, a network of drainage ditches, and small pumping plants; but the Snohomish still poured over their lands. They finally found a practical solution in cost-sharing and engineering opportunities offered through the 1954 Watershed Protection and Flood Prevention Act (Public Law 566).

French Creek people agreed to back a flood prevention project under sponsorship of the Snohomish Soil and Water Conservation District, French Slough Flood Control District, and Drainage District No. 4 of Snohomish County. Across the river, Marshland farmers moved ahead with plans for a project serving their area, with the soil and water conservation district, Marshland Flood Control District, and Drainage Districts No. 1 and 2 as sponsors.

Soil Conservation Service watershed specialists prepared plans, including engineering designs, economic evaluations, and cost estimates. The projects were cost-shared with $2.8 million of local and State funds and around $5,200,000 of Federal funds.

The Marshland flood works include a new 6½-mile long floodway, 3 to 80 feet wide, and another 2-mile floodway, expected to be in by 1966, that will drain the area around the Snohomish airport. Also to be completed by 1966 is about 8½ miles of new or enlarged, grass-seeded dike running along the south bank of the Snohomish River to an already completed pumping plant at Lowell.

The Marshland outlet structure, now operating, has six pumps, with a total capacity of 262,000 gallons a minute, which replaced four other pumping stations in a 4-mile stretch between Snohomish and Lowell. These smaller pumps can remove normal drainage waters from the 6,000 acres of lowland they serve. There also are four manually or automatically controlled floodgates.

When the water level in the river is lower than it is in the floodway, accumulated rain or snow runoff water flows by gravity off of the land in the floodway through the floodgates into the river. If the water level in the river below the floodgates is higher than it is in the floodway, the pumps lift the excess water out of the floodway over the floodgate structure into the river. The pumps operate at different levels and times in a sequence that moves the water down the floodway and through the outlets.

Structural measures on the French Creek project include: Reconstructing 2 miles of channel and building about 4 miles of dikes along the Snohomish and Pilchuck rivers; replacing a discharge pump on French Creek with now completed pumps along the Snohomish River bank; and 1 mile of floodway.

The French Creek outlet structure is similar to the Marshland plant except for its larger pumps of pumping capacity of 300,000 gallons a minute, and for fish

The authors are soil conservationist, Snohomish, Wash., and field information specialist, Berkeley, Calif., both of the Soil Conservation Service.

**PROBLEM.—Flooded pasture and crop land in Marshland area, with French Creek watershed in background.**

screens to protect migratory and sports fish. It has six floodgates.

With the flood hazard reduced, more effective onfarm drainage is possible in the Marshland and French Creek areas, as was borne out this year when new drainage channels ran bankfull, but there was no flooding of the adjacent land they were installed to protect. Because most of the conventional main ditches are not deep enough to drain wet lands, farmers in the Marshland area plan to install around 90 miles of closed and 12 miles of open drains in the next 10 years; and French Creek farmers plan to lay 165 miles of closed drains and dig about 10 miles of open ditches. Much of this work will be cost-shared with Agricultural Conservation Program funds.

Good drainage means longer growing seasons and reduces the marsh-type vegetation crowding out grasses and legumes needed for dairy cattle. The valley's chief cash crops—peas, corn, and broccoli—can't be grown on poorly drained land. With good drainage outlets, farmers can grow them in their rotations. Land preparation, fertilizing, and seeding now can be planned on a time schedule, and tillage is much less costly when the water level is controlled and soil is in shape to be worked.

Food processors and farmers welcome the projects, because they will open the way for a wider variety of cash crops. The economy of the Snohomish Valley should improve accordingly with wider choice of crops; and labor income in nearby processing plants is expected to increase.

Frank X. Bueler, Drainage District No. 1 commissioner and a Marshland farmer, puts it this way: "We have some of the best soil in the country, but we can't use it up to its producing ability."

Clarice Cedergreen, French Creek farmer and frozen foods processor says:

"The end of floods will enable us to grow cash crops on other acreages profitably."

"The greatest benefit from the projects will be the assurance that we won't be flooded out at every rise of the river," observed Chris Hansen, a commissioner of Drainage District No. 2. "The county will have less costly emergency repairs to roads and bridges, and public utilities will be helped. Government agencies helped us during flood disasters in the past. With the projects in, we are sure we won't need this help again."

Farmer Joe Crabbs commented: "Annual seedings are often needed because of prolonged overflows. We'll be able to choose grasses and legumes to fit our dairy enterprise."

Added Norman C. Wilson, Marshland farmer and chairman of the Snohomish district: "The winter water table will be lower, enabling us to grow better grasses and legumes."

**SOLUTION.—Marshland drainage outlet structure with 6 pumps and overhead crane.**

# Snow Survey Reports Help West In Years of Floods or Drought

By R. A. Work and William G. Shannon

MITIGATION of flood damages is among the major benefits that rural and urban communities gain from monthly winter snow surveys climaxed in April water supply forecasts for the West. So is the avoidance of crop-planting losses irrigation farmers might suffer in short-water seasons if they did not have this advance information to guide them.

The water supply forecasts for each snowmelt runoff provide a basis for more efficient use of water in the Nation's western areas. They are made in advance of the actual melt, or from January to as late as mid-June in some high mountain areas where snow falls late. The snow forecasts thus give water users and flood prevention authorities some time in which to plan for releasing, holding, or otherwise altering water storage in reservoirs used for hydroelectric power, flood control, irrigation, and other purposes.

That is why the Soil Conservation Service coordinates snow surveys made by its staff and many cooperators, including the Bureau of Reclamation, Corps of Engineers, Forest Service, National Park Service, Geological Survey, and other Federal agencies, departments of State government; irrigation districts, soil conservation districts, power companies, and others.

Its detailed reports on snow water conditions as they affect prospective streamflow and reservoir storage are made available immediately after the measurements are taken, as soon as possible after the first of each winter month. They are made on approximately 1,400 carefully located and marked SCS snow courses in major storm paths, by California on its separately operated 300 or more courses, and by British Columbia on its more than 100 snow courses. Flood control districts, the U. S. Weather Bureau, and others also receive the information.

The Soil Conservation Service does not forecast floods; but its findings on the amount of water stored as snow on mountain watersheds surveyed are used as flood prospects guides by those agencies and others concerned. Also used are Geological Survey stream-gage measurements, Weather Bureau precipitation and other reports, and all related information which make up the water supply forecasts made West-wide each April.

Based upon the water supply forecasts, savings from flood damages by reservoir control on these Columbia Basin streams are estimated to have been about $70 million during the 7 years from 1956 through 1962 alone.

Similarly, seasonal snowmelt forecasts are drawn upon the operation of reservoirs on the upper Colorado River, at Lake Mead on the lower Colorado, on the upper Missouri River, and on the Rio Grande. Snow forecast information also is used in the management of many smaller reservoirs, both publicly and privately owned, including watershed protection and flood prevention project reservoirs farmer and community groups are building in yearly increasing numbers on small tributary streams.

Most of these small-watershed impoundments are primarily for flood prevention, though more and more of them are being designed to serve such other purposes as recreation, municipal and industrial water supply, and irrigation. Most large reservoirs built in late years in the Western States likewise are multiple in purpose; that is, for irrigation, industry, municipalities, power, navigation, or recreation—and flood control. But to serve its flood prevention purpose effectively, it is important that the amount of water that will flow into a reservoir during the runoff season be known as far in advance as possible.

Snow surveys are made in 13 States: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming. The Alaska surveys have been primarily to build up, year-by-year, cumulative waterflow information for guidance in future development of storage.

Snow survey information is used, also, in Kansas, Nebraska, North Dakota, Oklahoma, and Texas, as well as in regional and national water planning.

New snow surveying techniques are making it possible to gather more dependable information from wider areas (see SOIL CONSERVATION, May 1959). These include remote mountain snowfields that were inaccessible to the men (and a few women, too!) who had to travel on skis or snowshoes to the snow courses from the time the first courses were laid out in 1910 until recent years. Track- and ski-type over-the-snow machines

The authors are head, water supply forecasting unit, Portland, Oreg., and civil engineer, Engineering Division, Washington, D.C., both of the Soil Conservation Service.

Top (l.).—Section of sampling tube with wrench for pushing it through deep snow. Center (l.)—Snow surveyors Bordon Goodwin (l.) and John Masterson check an Arizona soil moisture station. Bottom (l.)—Snow's weight on anti-freeze-filled rubber test "pillow" will operate adjacent water-content recording device. Top (r.).—Measuring next summer's snow water on Mount Hood in Oregon. Center (r.).—April's melting snow water on its way to the valley in Idaho. Bottom (r.)—Idaho floodwater did $120,000 damage in irrigated area on Snake River.

were the first break-through, to which aircraft was added. Today, also, more than 200 special snow depth measuring markers are read in midwinter by snow surveyors flying low over them. Meanwhile, short-wave radio long has been used to speed reports from snow surveyors at isolated courses to compilation centers.

Approximately 300 soil-moisture measuring stations, consisting of electronic resistance devices sunk as deep as 6 feet beneath the ground surface, are checked

The SCS also maintains about 100 precipitation gages which measure the total snow and rain which falls at snow courses. Taken together, this total amount of moisture received, the amount of the snowpack remaining on the surface, and the amount of water that still may or may not be needed to saturate the soil be neath the snow govern how much water may be expected in the streams and valleys below.

Telemetering systems are being tested, meanwhile, which automatically report the snow survey information from remote areas to designated receiving points.

# Colorado Small-Watershed Dams Stop Floods—Bring Recreation

By Dearl B. Beach

PEOPLE from Denver and the counties south and east of Colorado's largest city already are reaping major flood-prevention and recreational benefits from floodwater-retarding dams in the Big Sandy watershed protection project.

The dams saved farmers, townspeople, and other property owners from what otherwise would have been costly flooding down Big Sandy Creek last August. And 150 to 200 people from Denver, Littleton, Colorado Springs, and other points came on favorable weekends to fish or go boating or water skiing behind the Ramah Dam after it had been completed only 11 days before, on August 2, as rains first broke the drought which had plagued this and other parts of Colorado.

When storm clouds rolled over the headwaters of Big Sandy Creek northwest of Calhan on August 13, residents as far east as Ramah, Simla, and Matheson watched and remembered the floods in August 1954 and July 1956 that caused thousands of dollars in damages to agricultural land, highways and railways, and other property. But this time there was no flood, even though some observers said more than 3 inches of rain fell during the late afternoon storm.

The reason was that 4 of the watershed project's 14 strategically located flood-retarding dams caught and held the storm water long enough to keep the Big Sandy from flooding land and property along its course. Operation of the flood-retarding dams has been so effective that when two more storms, that formerly would have produced minor floods and damages, occurred on August 31 and on September 6, many residents never even realized a threat existed. By September 1, 1963, all but two of the dams had functioned at least once after rains; and six had functioned two or more times during August.

It was after the floods of the midfifties that the Board of Supervisors of the Big Sandy Soil Conservation District, with the support of the local citizens, and the State Soil Conservation Board applied for Federal help in developing a watershed protection and flood prevention project under Public Law 566. Technical assistance in project planning was given by the Soil Conservation Service of the U. S. Department of Agriculture; and the project was authorized in 1958 to receive financial help for installing the structures.

Under a supplemental authorization in 1961, the Ramah Dam 2½ miles west of Ramah, was planned to include fishing and recreation with its flood prevention purpose. The Colorado Game, Fish, and Parks Department agreed to share half the cost of the permanent storage for a 500-acre-foot fish pool in the dam—the only water stored by the 14 dams. All the dams have tubes through them, and floodwaters are released slowly over a period of days, thereby reducing flood damages.

With the exception of the Ramah Dam site and the adjoining public-use area, project farmers and ranchers donated the damsites and flowage rights to the Big Sandy Soil Conservation District. They then set out to apply the required soil and water conservation practices to protect the watershed above the structures and improve their grazing and cropland. Most of the more than 150 operating units in the nearly

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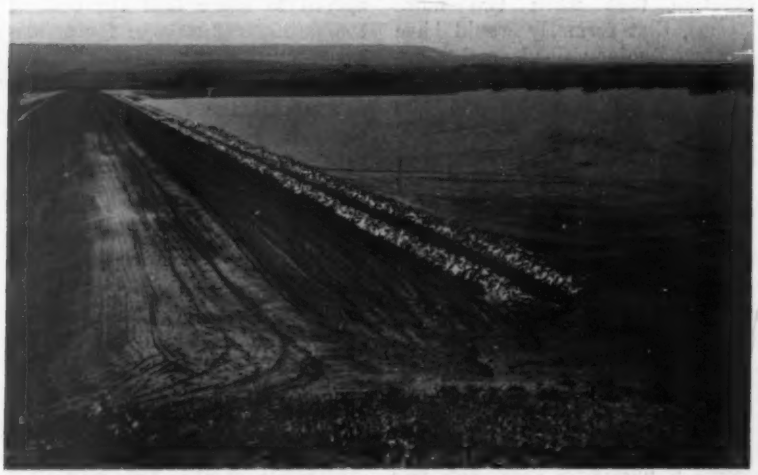
Water rising in Big Sandy Creek at Elbert County bridge during July 1956 flood at Simla, Colo.



New Ramah Dam with floodwater held back after heavy rain along the Big Sandy in August 1963.

200,000-acre watershed project area are district cooperators.

The project's estimated total planning and construction cost was $1,522,260, of which $1,055,000 was the Federal share and $467,260 the local contribution, including the sponsor's share of the permanent pool at Ramah Dam. Benefits, exclusive of the recreational values at the Ramah Dam, are estimated at $42,900 a year.

Maintenance of the dams, estimated to cost $4,000 annually, is the responsibility of the Big Sandy Soil Conservation District. This expense is being shared by the Chicago, Rock Island, and Pacific Railroad, which parallels Big Sandy Creek, and by El Paso and Elbert counties and the Colorado Game, Fish, and Parks Department.

The Colorado Department has plans for a recreational area on the north side of Ramah Lake. Facilities will include a parking area, picnic sites, comfort stations, and a boat dock. The lake already has been stocked with both trout and warm-water fish.

The Big Sandy Creek project, with the exception of the Ramah Dam, is similar to other watershed protection and flood prevention projects undertaken by Colorado citizens and their organizations at Trinidad, Wray, Kiowa, Greeley, and Castle Rock. Other projects which have been approved are at Limon, Grand Junction, and Olathe.